

- a flight tube that receives said secondary beam;
- an acceleration chamber that directs said secondary beam into said flight tube;
- an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;
- 5 a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;
- a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein  
10 said second portion is different from said first portion due to said different second electrical potential;
- a first preamplifier that receives said first signal and produces a first amplified signal in response;
- a second preamplifier that receives said second signal and produces a second  
15 amplified signal in response;
- a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;
- a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;
- 20 a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;
- a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,
- 25 a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

3/4

A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

5 an extraction chamber that produces a secondary beam of ionized particles  
from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

10 an electron multiplier that receives said secondary beam and produces an  
electron emission in response to each particle in said secondary beam;

a first anode that receives a first portion of each said electron emission and  
produces a first signal in response;

15 a second anode that receives a second portion of each said electron emission  
and produces a second signal in response wherein said second portion  
is different from said first portion due to the application of a magnetic  
field;

a first preamplifier that receives said first signal and produces a first amplified  
signal in response;

20 a second preamplifier that receives said second signal and produces a second  
amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal  
and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified  
signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

32 A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to said flight tube's physical geometry;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

5 a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

10 a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

33

A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

15 an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

20 an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

25 a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the

application of a magnetic field and said different second electrical potential;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

5 a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

10 a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

15 a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

34  
A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

20 transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

5 a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to said flight tube's physical geometry and said different second electrical potential;

10 a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

15 a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

20 a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

25

35  
A time-of-flight mass spectrometer comprising:

- an ion source that produces a primary beam of ionized particles;
- transmission optics that focus said primary beam;
- an extraction chamber that produces a secondary beam of ionized particles from said primary beam;
- 5 a flight tube that receives said secondary beam;
- an acceleration chamber that directs said secondary beam into said flight tube;
- an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;
- 10 a first anode that receives a first portion of each said electron emission and produces a first signal in response;
- a second anode that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the application of a magnetic field and said flight tube's physical geometry;
- 15 a first preamplifier that receives said first signal and produces a first amplified signal in response;
- a second preamplifier that receives said second signal and produces a second amplified signal in response;
- 20 a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;
- a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;
- a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

5

34

A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

10

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

15

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

20

a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the application of a magnetic field, said flight tube's physical geometry, and said different second electrical potential;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

25

a second preamplifier that receives said second signal and produces a second amplified signal in response;